Gamification of a Digital Health Technology for Unmotivated Smokers: Concept and User-driven Development

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Abstract

Digital health technologies most often reach only those more motivated to engage, particularly when preventive health is targeted. To test whether gamification could be used to engage the unmotivated, we conceptualized "Take a Break" - a three-week technology-assisted challenge for smokers to compete in setting and achieving brief abstinence goals. Usability testing of the multi-technology Take a Break challenge was performed by a panel of smokers. These smokers were given 1) daily motivational messages, 2) brief "challenge quizzes" related to smoking behaviors, 3) a telehealth call to personalize their abstinence goal for the challenge and 4) a set "coping mini-games" to help manage cravings while attempting to achieve their brief abstinence goals. Fifth, a leaderboard "webApp" gave feedback on smokers' participation compared to others engaged in the challenge, allowing for competition. We used usability testing to further refine the elements. Meaningful gamification was successful in engaging unmotivated smokers

1. Introduction

The last decade has seen a rapid proliferation of digital technology to support health management and health care delivery [1-5]. Examples of such digital technology include wearable activity monitors, electronic and mobile health, and patient portals. There is considerable hope that these technologies will help improve health and health care [1-5]. These technologies often only successfully engage a subset of the most motivated users. Data on wearable activity monitors have shown those currently using this technology are those already leading a healthy and active lifestyle [5, 6]. Much of the population who might benefit most from health technologies belong to the unmotivated majority [7]. Even among the motivated subset, data shows these health technologies are discarded after initial use [8]. Innovative approaches to expand the use of digital health technologies by unmotivated users and to keep users engaged are needed.

Gamification, a promising approach to increase engagement, is the use of game design elements in non-game contexts [9]. Although gamification has been shown to promote engagement beyond the realm of games [10], it has not been used to reach and continually engage unmotivated populations in behavioral support using digital technology. Using behavior change and game design theory, we conceptualized a set of gamified mobile health tools for inveterate smokers, called Take a Break. These tools attempt to engage unmotivated smokers in a brief experience designed to increase motivation for cessation and prepare them with skills to be successful during a future attempt to quit tobacco. In this paper, we describe 1) our conceptual frameworks for development of five game elements, and 2) usability testing of the elements.

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2. Methods

Our goal in the use of gamification in Take a Break is to increase the engagement of low motivation smokers in evidence-based behavior support. While gamification primarily enhances external motivation (e.g.: gaining momentary rewards), research has shown additional changes in internal motivation (long-lasting resolve) and user behavior are possible with careful design [9, 11, 12]. We will describe the conceptualization of intervention elements using game design and behavioral theory for enhanced motivation, as well as usability testing of the intervention elements.

2.1. Intervention Elements Conceptualized

A recent review suggests that tobacco cessation interventions must provide smokers the opportunity to reflect upon smoking, briefly practice behaviors used while quitting, and develop new skills for managing smoking urges [13]. The Take a Break game experience provides smokers these opportunities using content supporting reflection on tobacco use and skill development. The Self-Determination Theory (SDT), a theory of motivation, purports three psychological needs are necessary for optimal motivation to be developed: relatedness to others, autonomy, and perceived competence [14]. These three needs were used to guide the content of the intervention elements to affect smoker motivation. Game design concepts identified to support motivation [15] were then mapped to the three psychological needs of SDT (relatedness to others, autonomy, and perceived competence) in order to guide gamification of the intervention elements.

Overall, 5 gamified intervention elements were created and a 3-week experience for unmotivated smokers was constructed to move them along motivation continuum. The technology is briefly described in Table 1. The first week is a training and assessment period, verifying participants are able to receive and respond to 1) Motivational Messages written by smokers for other smokers to enhance game play and motivate cessation; and 2) Challenge Quizzes to assess daily smoking behavior and attitudes about smoking that could help smokers be more mindful of their behavior and feelings. During a telehealth call with the Tobacco Treatment Specialist (TTS), 3) a goal is set for the number of days during the challenge they decide to attempt being abstinent from smoking. After the call, the two-week challenge begins. Intervention elements 1-3 are continued, along with two others: 4) Coping Mini-Games designed to help smokers overcome cravings for cigarettes; and 5) Recognition and Rewards including points for participation. Further description of these intervention elements are reported below. Components of gamification imbedded in these elements are described in Table 2. Affiliation with others supports relatedness by creating a sense of connectedness with other smokers, whether through smoker-generated messages, goals, or participation shown on a leaderboard. Autonomy was supported through designing elements to contain choices, for choices to contain novelty and variety, and the freedom to choose a focused goal. Lastly, opportunities to gain perceived competence were designed into elements, including protection from adverse consequences from initial "failures", affirmation of performance, challenging tasks and clear & compelling standards.

2.1.1. Element 1: Motivational Messages. Daily motivational messages set expectations on the benefits of taking a break from smoking and were written by experts and smokers. Expert-written messages were developed iteratively through a group review, and the content was guided by current guidelines [16] and Social Cognitive Theory [17]. Smoker-written messages were written by smokers responding to scenarios that varied by a character's readiness to quit smoking. These messages were previously evaluated within the context of a web-assisted tobacco intervention [18, 19].

2.1.2. Element 2: Challenge Quizzes. The purpose of the challenge quizzes is three-fold: 1) to engage smokers, 2) enhance self-awareness of smoking behaviors, and 3) collect data on situational characteristics, abstinence behaviors, and cravings to inform the telehealth call at the end of week one. Two challenge questions are sent daily over text messaging, asking the number of cigarettes that were smoked in the last 24 hours and, if answered, asking an additional question prompting self-assessment of their cravings. The self-assessment of cravings come from the anger and anxiety subscales in the 28-item Wisconsin Smoking Withdrawal Scale [20], and were adapted for text messaging. Affirmation of response is given by congratulating the participant and notifying them of points earned.

2.1.3. Element 3: Goal setting. The gamification strategy of giving smokers control over the goal increases the meaningfulness of the game element [21]. As noted, after the initial one-week training period the smokers receive a telehealth call, with the

Table 1. Characteristics of a Mobile Multi-Technology Intervention: Take a Break

Health Topics:	Tobacco cessation, cravings, low-motivated smokers	
Targeted age group:	Adults	
Other targeted group characteristics:	Unmotivated to quit tobacco use	
Short description of game idea:	Mobile messaging and applications to support a personal challenge to take a break from smoking.	
Target player:	individuals	
Guiding knowledge or behavior theories, models or conceptual frameworks:	Self-Determination Theory (SDT), game design concepts based on the Theory of Intrinsically Motivating Instruction, Organismic Integration Theory (OIT)	
Intended health behavior changes:	Days of abstinence during challenge and long-term cessation from tobacco	
Knowledge elements to be learned:	Benefits of quitting tobacco and how to deal with cravings]	
Behavior change procedures (based on Michie inventory) or therapeutic procedures employed:	Self-reward [10.9], Anticipation of future rewards or removal of punishment [14.10], Incentive [10.1], Behavioral rehearsal/practice [8.1], Distraction [12.4], Goal setting (outcome) [1.3], Review of outcome goal(s) [1.7],	
Clinical or parental support needed?:	Tobacco treatment specialist telehealth call after 1 week is provided, with session focused on goal-setting.	
Data shared with parent or clinician:	Week 1 answers reviewed prior to telehealth call	
Type of game:	Educational, casual, experiential, motivational	
Game components	**Technology**	**Goal/objective**
1. Motivational messages:	Daily SMS	Set expectations on the benefits of taking a break from smoking.
2. Challenge quizzes:	Daily SMS	Engage smokers and enhance self-awareness of smoking behaviors.
3. Goal-setting:	telehealth	Encourage the smoker to set a realistic goal for the challenge period.
4. Coping Minigames:	Mobile Apps made by third party providers	Help smokers manage cravings.
5. Recognition & Rewards:	WebApp	Link the external goal of scoring points by replying to daily challenge quizzes along with the internal goal.
Player's game goal/objectives:	Enhance motivation to take a short-term break from smoking and a long-term quit attempt from tobacco.	
Procedures to generalize or transfer what's learned in the game to outside the game:	Enhance intrinsic motivation to quit tobacco through the message content, encouraging view and use of content via gamification of points and rewards.	
Game platform needed to play the game:	smartphone	
Estimated play time:	All components are point-of-need access via smartphone over 3 weeks. Motivational messages and challenge quizzes: Sent daily over 3 weeks, estimated <1 minute per message or quiz. Goal-setting: One-time telehealth call of 15 minutes. Coping Minigames: self-initiated, 5 minutes per use. Recognition & Rewards: accessed briefly to check score.	

primary goal of this call is to encourage the smoker to set a realistic goal of the number of days they will stay quit during the challenge period.

2.1.4. Element 4: Coping Mini-Games. Cravings, an intense desire or longing for a cigarette [22], are a major contributor to quit attempt failure [23]. Relaxation and distraction are commonly recommended approaches to help smokers manage cravings [16, 24]. Coping mini-games include distraction and relaxation mobile applications (apps) that can help distract smokers during their cravings.

2.1.5. Element 5: Recognition & Rewards. We promote engagement using a gamification system based on Organismic Integration Theory (OIT) [21], linking the external goal of scoring points by replying to daily challenge quizzes along with the internal goal of reflecting on the content of the challenge quiz questions. A set of key principles to guide the scoring and reward structure include 1) points are rewarded immediately after participation, 2) points earned would increase as participation increased, 3) points would be tracked on a leader board accessible to participants, and 4) rewards and recognitions would be distributed to all participants, with participants who score the most points will receive the greatest reward.

2.2. Usability Testing

The development of intervention elements included a usability inspection process by our team of experts and panel of smokers on each intervention element, described below. Usability inspection methods used included heuristic evaluation and cognitive walk-through with a team of experts in game design, behavioral interventions, and tobacco cessation [25]. We recruited a panel of eight smokers who were not intending to quit smoking to gain in-depth feedback on each intervention element. Panel size was selected based on the requirement of three or more users to perform heuristic evaluation and cognitive walk-through [25] and the majority of issues in think aloud testing can be identified with 4±1 users, with progressively diminishing returns [26]. Not every smoker gave feedback on each element, but only those available to test the element as needed. Our study was approved by the University of Massachusetts Medical School Institutional Review Board.

3. Results

Between three to seven smokers participated in testing each of the intervention elements during usability testing. Further description of the usability testing for each element are described below.

3.1. Motivational Messages

As noted above, these messages were rigorously tested in prior trial. [19] For Take a Break, our goal was to select a subset of messages to use during the two-week challenge, and to collect user feedback on whether these messages were helpful to motivational phase smokers. We used a previously-developed procedure [18], where team experts separately rated 50 messages, with each message receiving a score ranging from 1-5 in perceived usefulness. The questions that received the highest ratings from team experts were discussed. Fourteen of the messages were selected. Panel members (N=3) piloted the motivational messages for 2 weeks, reporting messages were easy to read and delivered at an acceptable the time of day.

3.2. Challenge Quizzes

Heuristic evaluation of the challenge quizzes was performed with experts receiving the challenge quiz questions on their phones and trialing responses. Panel members (N=3) tested the challenge quizzes for 1 week and were asked for feedback. Panel members felt that the number of messages sent per day was appropriate and questions were clearly worded. A panel member suggestion of adding an example of the desired response language for the number of cigarettes smoked each day (ie. “0 or 12 or 20”) was incorporated.

3.3. Goal-setting

The TTS developed the protocol for the telehealth call, including how to elicit a goal of abstinence days from smokers during the 2-week challenge. The TTS practiced the telehealth call with team members to refine techniques to assist smokers to identify a goal. Panel members (N=3) then participated in a telehealth call, leading to an additional revision of the protocol to assist smokers in choosing a realistic goal that fits within the 2-week challenge period.

Table 2. Game Design Concepts informing Intervention Elements

Self-Determination Theory	Related Game Design Concept(s)[a]	Take a Break Intervention Elements: Motivational Messages	Challenge Quizzes	Abstinence Challenge Goal-setting[b]	Coping Mobile Apps	Recognition & Rewards
Relatedness	**Affiliation with others**	Includes Messages written "by smokers for smokers"		Range of goals from past participants shared with new smokers		"Leaderboard" allows smokers to compare their points with others
Autonomy	**Choice**	Message goal is to inform, motivate, but not to promote long-term cessation	End of week 1, motivational interview with TTS focuses on lessons learned from response to questions	Smokers Choose goal during abstinence challenge	Smokers choose Apps Provided a menu of downloadable Apps	
	Novelty & variety	Topics vary from health to social and economic consequences of smoking	Questions on elements of nicotine withdrawal gives daily self-assessment opportunities	Autonomy supported by allowing any goal, including zero days	Apps for both relaxation and distraction	Points collected for a variety of tasks
	Short-term, Focused Goals		Each question a separate "quiz"	Abstinence Challenge only 2 weeks, creates sense of urgency and focus		Rewards for self-report of abstinence, use of NRT[c], and CO[d] measure
Perceived Competence	**Protection from adverse consequences for initial failures**		Given second chance for each question	Providing a 2-week period for smokers allows for multiple attempts at abstinence goal		Majority of points for participation, not achievement of abstinence
	Affirmation of Performance		Two-way texts provide positive feedback			Reward messages note daily points achieved
	Challenging tasks		Questions challenge smokers to think about smoking behaviors	Recognize that abstinence even for one day is a challenging task	Managing immediate cravings is key to short-term abstinence	
	Clear & compelling standards			Setting a numerical goal for abstinence days give smokers a clear target		Comparing rewards with others compels smokers to work towards a self-identified standard
Timeline		Weeks 1-3	Weeks 1-3	end of Week 1 on telehealth call	Weeks 1-3	Weeks 1-3 and end celebration

[a]Game Design Concepts that support motivation[15] originate from Theory of Intrinsically Motivating Instruction [27]
[b]Goal-setting for abstinence with a Tobacco Treatment Specialist [c]Nicotine Replacement Therapy [d]Carbon monoxide

3.4. Coping Mini-games

Coping mini-games for smokers to use during their cravings to use tobacco needed to be identified. First, distraction and relaxation mobile apps were selected from Google and Apple for evaluation. Search criteria included compatibility across interfaces, no cost, high download rate, and short duration. Fifteen apps fit the criteria. Experts discussed the strengths and weaknesses of each, resulting in six apps selected for panel member testing. A Think Aloud evaluation was used, with panel members asked to vocalize thoughts, feelings, and opinions while using the apps [28, 29]. Panel members (N=7) varied on their app preferences. For example, one member responded, "I love this game. It's challenging and distracts you, keeps you busy…it's addicting." In contrast, another member responded, "Games like this are stressful for me, maybe because I am a stressful smoker." The panel preferred multiple apps to choose from. Thus, a suite of apps was included in this element, including three distraction apps (Piano Tiles, Flow Free, and Word Streak) and three relaxation apps (Calm, Breathe2Relax, and Take a Break!) (Table 3).

3.5. Recognition & Rewards

The team performed a cognitive walk-through of the points system and discussed tangible rewards to be given that reflect the virtual awards smokers earned. Virtual awards (gold, silver or bronze medals) translated into tangible rewards of gift cards for a pharmacy that sells nicotine replacement therapy (NRT) and not tobacco. Panel members (N=3) gave qualitative feedback on the likeability of the leaderboard and rewards. Smokers preferred point distributions of 10 to promote a sense of accomplishment and approved of gift card and the varying amounts that correspond with the medals.

4. Discussion

A State of the Science conference on tobacco research emphasized that interventions need to be more palatable and engaging for all smokers [30]. We packaged a smoking cessation intervention as a gaming experience and developed the gaming elements through usability testing, with the goal of enhancing engagement with unmotivated smokers. Usability of the intervention elements were tested and modified based on smoker panel feedback.

It is now well accepted that the phrase "if you build it, they will come" is a fallacy. The packaging of the digital technology is important to promote engagement and ultimately the effectiveness of the technology. In our study, we packaged a smoking cessation intervention as a gaming experience and have developed the gaming elements. These elements were informed by a usability evaluation. Key findings of the usability evaluation include that smokers selected and preferred a variety of apps to support themselves during the challenge period. Among the smokers that participated in our evaluation, the gaming experience succeeded in increasing their engagement, as measured by response rates to challenge quizzes and self-reported use of apps. Even among unmotivated smokers, the intervention succeeded in encouraging smokers to set a goal for abstinence from smoking during the 2-week challenge period. Smokers liked the rewards and recognition program, thought it was motivating, and were excited to compete with their peers.

In testing the apps, consensus was not reached for selecting a single mobile application as the best in distracting or relaxing smokers during tobacco cravings. Smokers varied in their app preferences, and even had contradicting opinions. However, all smokers preferred a suite of games to several pre-selected options, influencing our element design to include six apps. In our real-world testing, we did not find confusion among smokers when presented with multiple options of apps. An implication of this finding for intervention developers is to be flexible. Allowing the participants choose based on personal preference is likely a better approach. An even more advanced approach may be to develop algorithms to tailor the apps provided to each participant based on their personal preferences. For example, tailoring the suite of games to provide a challenging game, such as Piano Tiles, to a participant who likes challenges, but not to a participant who is triggered to smoke by stressful experiences.

In general, most smokers attempting a quit attempt do not incorporate evidence-based methods in their efforts, and success rates for tobacco cessation are low (7%) [16]. Thus, getting smokers to use these evidence-based methods (distraction and relaxation) is an important priority. Smokers felt that the number of messages sent per day was appropriate (a maximum of 3 per day). Similarly, a text-messaging intervention to college-age tobacco users in Sweden, NEXit, found 2 to 4 text messages were acceptable [31]. Multiple text message studies for smokers found five messages per day were reported by users as too many [31, 32]. Maintaining a balance

Table 3. Usability Testing of Coping Mini-Games

Distraction Apps	
App Description	**Participant Feedback**
Don't Tap The White Tile (Piano Tiles)[1] Features: • Variety of game modes, colors and songs/rhythms; customizable • Rank against friends and support from friends using Facebook or Twitter	"I love this game. It's challenging and distracting, keeps you busy…it's addicting." "This game is long enough, it keeps me distracted and away from smoking" "Games like this are stressful for me, maybe because I am a stressful smoker."
Flow Free[2] • Puzzle game • Solve levels and with accuracy, efficiency and speed • Customizable time trials, scores included	"I'm not a pattern person but I think I like this game better than I thought. I like the bright colors" "I get stressed while playing this game, it makes me more stressful " "It might be somewhat helpful to control
Word Streak[3] • Varying speeds, badges • Challenge and chat with friends using Facebook	"Game is very engaging, it keeps my mind alert" "It's a good game but it has to be longer to keep me from cravings"
Relaxation Apps	
App Description	**Participant Feedback**
Calm - Meditate, Sleep, Relax[4] • Guided meditation sessions • Varying lengths of sessions, topics, music/sounds and depth for beginners and advanced • Track daily streaks and time	"Love the beach scene" "Different scenes and sounds are really helpful" "Running water, rain and ocean breezes are very good"
Free Meditation - Take a Break[5] • Voice-guided meditations • 2 meditations to choose from, choice of with or without music	"I like scenery, like beach, lakes" "I like sound of rain, ocean, beach and water running. I love sounds" "Don't like meditation, it's not for me"
Breathe2Relax[6] • Stress management • Learn skill: diaphragmatic breathing • Practice exercises	"Breathing exercise is really helpful to relax" "I love the blue scenery and the tutorial, it's very helpful" "Don't like the stress tracker"
Notes. Sources: [1]https://piano-tiles.com/dont-tap-the-white-tile.html; [2]https://www.bigduckgames.com/flowfree; [3]https://www.zynga.com/games/words-with-friends-2; [4]https://www.calm.com/; https://itunes.apple.com/us/app/calm.com/id571800810; [5]https://www.meditationoasis.com/app-support; [6]http://telehealth.org/apps/behavioral/breathe2relax-mobile-app	

between prompting a user versus irritating a user is important in design. Usability evaluations before the main trial can help studies understand the number of text messages that is palatable to a user in their targeted population.

There were variations in the number of days that smokers set as their goal for abstinence during the challenge. The low number of goal days was by design as our TTS encouraged smokers to set a realistic goal, to prevent these smokers from getting discouraged. However, the act of setting a goal to attempt a quit experience is an important step towards long-term tobacco cessation for unmotivated smokers [33]. The smoker-determined proximal goal of testing abstinence for a self-defined number of days assists smokers to trial abstinence from tobacco without feeling compelled to quit indefinitely. The gamification strategy of giving smokers control over the goal increases meaningfulness of the game element [21]. Along with the incorporation of evidence-based tools, including distraction tools and motivational messages, we anticipate that these unmotivated smokers will be more successful in their quitting efforts. In our larger randomization trial, we will follow smokers for six months and determine the intervention's effect on self-efficacy and tobacco cessation.

4.1. Strengths and Limitations

In preparation for a larger randomization trial testing the game and a mobile health platform for smokers who are not ready to quit, we detail the development of game elements designed to engage this challenging population. Each element of the game is mapped to a gaming theory concept to ensure meaningful gamification. Each element was refined using usability testing. Although the numbers of users are low, the multiple and comprehensive nature of the interactions and process data collected allowed improvement of elements for enhanced smoker motivation in planning a quit attempt. In our larger trial, Take a Break, we will compare the effect of the gaming elements described in this paper with an attention control of Nicotine Replacement Therapy sampling and a phone call with a tobacco treatment specialist on the main outcome of tobacco cessation.

5. Conclusions

The development and testing of a digital health technology for behavioral intervention in unmotivated smokers described. First, we used game design principle to conceptualize and design the game elements included in the intervention. Second, we used usability testing to further refine the elements for testing. Meaningful gamification was successful in engaging unmotivated smokers during usability testing. Further testing of Take a Break in a larger trial is needed to determine the game elements' effect on tobacco cessation.

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